

論文 / 著書情報
Article / Book Information

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論文要旨

THESIS SUMMARY

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申請学位 (専攻分野):	博士	(Engineering)
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要旨 (英文 800 語程度)

Thesis Summary (approx.800 English Words)

The poultry industry produces an enormous amount of feather waste each year, and only a little part of them is utilized. Since feathers are traced with blood and may have a significant load of pathogenic microorganisms, their accumulation poses serious risks to the environment and public health. The complex structure of feathers is making it also resistant to degradation by most plant, animal, and microbes. On the other hand, feather waste is promising protein biomass which has a high N content (up to 15% on the dry weight basis) which mean that they represent a renewable source of N for plant nutrition. Due to poor degradability characteristics of the feather, the release of N from feathers to soil was not adequate to improve plant response which makes the pretreatment inevitably needed. Therefore, from both an economic and environmental point of view, it is quite desirable to develop an effective and profitable process to use these resources. In this study, hydrothermal treatment (HTT) was proposed as the method to produce feather-based liquid fertilizer by recovering the nutrient and enhancing the N release characteristics from the raw feather.

First, the lab-scale investigation on HTT of the feather was performed to analyze the effect of treatments on the feather solubilization rate, the liquid composition, and the physicochemical properties of the liquid product. The HTT experiments were investigated at four reaction temperatures (140, 160, 180, and 200 °C) with the holding time of 30 minutes. The results indicated that the HTT temperature has a prominent effect on the N solubilization rate, the N distribution in the HTT products, the N form, and the phytotoxicity of the produced liquid fertilizer. HTT with a lime addition at the reaction temperature of 180 °C, for 30 min at the 1:5 feather-water ratio can produce a liquid that contains nitrogen of 3.3% and the total amino acid content of 13.6%. During the hydrolysis of organic compounds, normally several transformations and degradation reactions, as well as the formation of new organic compounds occur which can have a toxic effect on the plant. Therefore, to prevent phytotoxic damage of the produced liquid, it should be diluted appropriately.

Nitrogen in the liquid feather hydrolysate mostly presents in an organic form (84.0-93.5%) which must

be mineralized into inorganic forms before it is available for the plant uptake. An incubation experiment was conducted to investigate the N availability of the liquid product. Addition of liquid feather hydrolysate to two types of soil in a laboratory incubation study exhibited a rapid increase in soil inorganic N, which indicates relatively high mineralization of hydrolysate N. Approximately, 34 – 51% of the total N content in the feather hydrolysate-treated soils was mineralized during 30 d incubation which is higher than mineralization of typical composts. A higher mineralization rate was observed at the mineralization the liquid product obtained at a higher HTT temperature possibly due to less complex N compounds contained in the sample.

The plant growth experiment was conducted to test the effect of the liquid product on the plant. The effect of the application of sole feather protein hydrolysate (FPH), chemical fertilizers, and their combinations on the growth and yield of two plants (patchouli and mung bean) was investigated. The combined application of FPH and 50% chemical fertilizer gave a statistically significant impact on the growth parameters of leafy plant such as patchouli. Moreover, the combined treatment showed similar response with 100% chemical fertilizer suggesting that the application of FPH along with the chemical fertilizer can increase the fertilizer use efficiency. There is a tendency on improvement on fruit development and yield by application of FPH on the mung bean plant. These FPH products could be of practical interest in reducing the use of chemical fertilizers.

Finally, feather hydrochar, a solid by-product of HTT, was investigated for its stability to seek its suitability to be used as soil amendment. The stability of feather hydrochar was compared with common biomass-derived hydrochar, including bagasse (lignocellulosic biomass) and manure. HTT altered the physicochemical composition of biomass, which consequently influenced the stability of the produced hydrochar. After HTT, H/C and O/C ratios decreased which indicated an increase in aromaticity. From the XPS study, it could be suggested that HTT diverted the hydrochar stability through the change in the C and N functional groups. The stability of hydrochars followed the sequence of bagasse > manure > feather. Considering a high C content and C/N ratio, as well as a greater stability, the bagasse hydrochar as lignocellulosic materials is more suitable for C sequestration purpose. On the other side, a high N mineralization makes the feather hydrochar suitable for improving soil fertility.

The application of HTT on poultry feather waste enable rapid degradation of high-rigidity keratin structure and provide sterilization process to inactivate the pathogenic microorganisms. The liquid product demonstrated an enhanced N availability, and its potential to improve crop productivities. Moreover, the use of the liquid product as fertilizer can potentially reduce the use of chemical fertilizer. The conversion of the feather into liquid fertilizer can be a promising way to deal with an environmental

issue of improper feather waste disposal while enabling effective resource utilization.

備考：論文要旨は、和文 2000 字と英文 300 語を 1 部ずつ提出するか、もしくは英文 800 語を 1 部提出してください。

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